UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM March 25, 2002

SUBJECT: Corrected version of EFED's eco portion of SRRD's April 2001 Disulfoton IRED

FROM: Henry Craven, Biologist, ERB 3, EFED (7507C)

THRU: Kevin Costello, Acting Branch Chief ERB 3, EFED (7507C)

TO: Betty Shackleford, PM 53
Christina Scheltema, PM Team Reviewer
Michael Goodis
Reregistration Branch 3
Special Review and Reregistration Division (7508W)

This memo serves to transmit the corrected version of EFED's 8/20/01 modification of EFED's Eco portion of SRRD's April 2001 Disulfoton IRED. Included is the output files for a number of runs of the terrestrial exposure model--FATE5.

B. Environmental Risk Assessment

A summary of the Agency's environmental risk assessment is presented below. For detailed discussions of all aspects of the environmental risk assessment, see the document, *Preregistration Eligibility Decision for Disulfoton*, dated January 13, 2000, available in the public docket and the most recent amendment to this document, dated September 5, 2000.

The environmental risk assessment for disulfoton has been refined with new information submitted during phases 3 and 5 of the public participation process. This information included proposed changes to the disulfoton registration, such as reductions in the rate and frequency of application, to mitigate risks, as well as public comments on environmental risk and drinking water.

1. Environmental Fate and Transport

In soil, disulfoton is not expected to undergo significant hydrolysis or volatilization. Disulfoton parent is photochemically degraded rapidly by sunlight on soil and in water where light can penetrate. Disulfoton is metabolized or oxidized in soil to the corresponding sulfoxide and sulfone degradates. Degradation of disulfoton parent in soil does not appear to follow first-order kinetics, but the half life is less than 6 days. Field dissipation studies confirm that disulfoton does not persist in the environment. EPA does not have data on the anaerobic metabolism of disulfoton. Disulfoton is not considered mobile under convective-dispersive processes, but it has been detected in groundwater monitoring conducted in highly vulnerable areas.

Disulfoton degrades in the environment. The major degradates, disulfoton sulfone and sulfoxide, are more persistent and mobile than the parent. As much as 35% of the applied disulfoton remained in soil as disulfoton sulfone after 367 days. Thus the degradates appear to be much more persistent than parent in soil. The other degradates were either not identified or occurred at much lower concentrations. However, the Agency is concerned that the sulfoxide and sulfone degradates have a high potential to reach ground and surface water. In field testing, degradates were detected at a depth of 18 inches, indicating potential mobility. The Agency has limited data regarding the persistence of the degradates and lacks the absorption/desorption data necessary to confirm the mobility of the degradates. Aerobic and anaerobic aquatic metabolism studies are required for the parent and degradates. A study on the mobility and leaching potential of the degradates is also required.

2. Water Resources Assessment

The water resources assessment is summarized earlier in this document. The surface water EECs shown in Table - were used to assess potential drinking water exposure to disulfoton. The drinking water assessment has been refined to include the percent crop area

factor and the index reservoir. However, the ecological water resources assessment does not include the refinements mentioned above. The Agency's current policy is to include these refinements in the drinking water assessment but not in the ecological risk assessment because the " unrefined" farm pond on the edge of field scenario is thought to better represent the conditions for ecological exposure. For more information, see *Preregistration Eligibility Document for Disulfoton*, September 5, 2000.

3. Ecological Risk Assessment

The Agency's ecological risk assessment compares toxicity endpoints from ecological toxicity studies to estimated environmental concentrations based on environmental fate characteristics, pesticide use, and/or monitoring data. The Agency first assesses the acute and chronic toxicity to each of four groups of nontarget animals. Acute toxicity is expressed as follows:

-EC_{50} (invertebrates),
-LC_{50} (fish and birds), and
-LD_{50} (birds and mammals)

Chronic toxicity is expressed as follows:

-NOAEL or NOAEC for avian and mammal reproduction studies, and *either*
-The NOAEL for chronic aquatic studies, *or*
-The Maximum Allowable Toxicant Concentration (MATC).

To estimate potential ecological risk, EPA integrates the results of exposure and ecological toxicity studies using the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by ecological toxicity values, both acute and chronic, for various species. These RQ values are compared to levels of concern (LOCs), which provide an indication of the relative risk the particular pesticide and/or use may pose for nontarget organisms. In general, the higher the RQ the greater the concern. The LOC indicates whether a chemical, when used as directed, has the potential to cause undesirable effects on nontarget organisms. When the risk quotient exceeds the LOC for a particular category, the Agency presumes a risk of concern to that category. The LOC's and the corresponding Risk presumptions are presented in the following table:

Table 9. Levels of Concern (LOCs) and Associated Risk Presumption

IF...	THEN the Agency presumes...
Mammals and Birds	
The acute RQ > LOC of 0.5,	Acute risk
The acute RQ >LOC of 0.2,	Risk that may be mitigated through restricted use
The acute RQ > LOC of 0.1,	Acute effects may occur in Endangered species
The chronic RQ > LOC of 1	Chronic risk *and* Chronic effects may occur in Endangered species

IF...	THEN the Agency presumes...
Fish and Aquatic Invertebrates	
The acute RQ > LOC of 0.5	Acute risk
The acute RQ > LOC of 0.1	Risk that may be mitigated through restricted use
The acute RQ >LOC of 0.05	Acute effects may occur in Endangered species
The chronic RQ > LOC of 1	Chronic risk *and* Chronic effects may occur in Endangered species
Plants	
The RQ > LOC of 1	Acute risk
The RQ > LOC of 1	Endangered plants may be affected

No separate criteria exist for restricted use or chronic effects for plants.

Risk characterization provides further information on the likelihood of adverse effects occurring by considering the use pattern of the pesticide; its fate in the environment; the species and populations of organisms potentially at risk, their spatial and temporal distributions; and the nature of the effects observed in toxicity studies.

a. Toxicity of Disulfoton to non target organisms

The Agency has a fairly robust toxicity database for disulfoton and the two primary degradates, disulfoton sulfoxide and disulfoton sulfone. The following table contains the toxicity values used in the terrestrial animal risk assessment

Table 7. Toxicity endpoints used in assessing risk of terrestrial organisms for disulfoton

Species	Test Type	Results (ppm ai)	Toxicity Classification	Source of Data
Japanese quail	sub acute dietary	LC50=333	highly toxic	0034769
Northern bobwhite quail	sub acute dietary	LC50) = 544	moderately toxic	0094233
Northern bobwhite quail	sub acute dietary	LC50 (sulfone metabolite) = 558	moderately toxic	42585106
Northern bobwhite quail	sub acute dietary	LC50 (sulfoxide metabolite) = 456	highly toxic	42585105
Mallard duck	acute oral	LD50=6.54 mg ai/kg	very highly toxic	00160000
Mallard duck	reproduction	NOAEC=37 LOAEC=80 (decreased adult and hatchling body weight)	N/A	43032502

Species	Test Type	Results (ppm ai)	Toxicity Classification	Source of Data
Laboratory rat	acute oral	LD50=1.9 mg ai/kg	very highly toxic	072293
Laboratory rat	acute oral	LD50 (sulfone metabolite) =11.24 mg /kg	highly toxic	0071873
Laboratory rat	acute dietary	1-day LC50[1] (2 to 12.7ppm)	highly to very highly toxic	N/A
Laboratory rat	2-generation reproduction	NOAEL=0.8 LOAEL=2.4 (decreased litter size and pup survival)	N/A	261990
Honey bee	acute contact	LD50 = 4.1 ug ai/bee	moderately toxic	05004151
Honey bee	acute contact	LD50 (sulfone metabolite) = 0.96 ug/bee	highly toxic	42582902
Honey bee	acute contact	LD50 (sulfoxide metabolite) = 1.11 ug /bee	highly toxic	42582901
Honey bee	acute foliar residue	[2]RT25 (8 EC) < 3hrs at 1.0 lb ai/A	N/A	0163423

1 one-day LC50 = LD50 (mg/kg) / proportion of body weight consumed. The mammalian LD50 of 1.9 mg/kg was used to estimate 1-day LC50s ranging from 2 ppm for a 15 gram herbivore (consumes 95%) to 12.7 ppm for a 1000 gram granivore (consumes 15%)
2 RT25 (residual time) time required to reduce mortality of caged bees to field weathered spray deposits.

Table 8. Toxicity endpoints used in assessing risk of aquatic organisms for disulfoton				
Freshwater Species*	Test Type	Results (ppb ai)	Toxicity Category	Source of Data
Bluegill	Acute	LC50=39	very highly toxic	00068268
Bluegill	Acute	LC50 (sulfone metabolite) =112	highly toxic	42585108
Bluegill	Acute	LC50 (sulfoxide metabolite) =188	highly toxic	42585107
Bluegill	Early Life Stage**	estimated NOAEC = 4.6		Extrapolated from 41935801
Glass shrimp	Acute	EC50=3.9	Very highly toxic	40094602
Water flea	Life Cycle	NOAEC=0.037	N/A	41935802
Water flea	Life Cycle	NOAEC (sulfone metabolite) =0.14	N/A	43738001
Water flea	Life Cycle	NOAEC (sulfoxide metabolite) = 1.53	N/A	43738002
Marine Species*				
Sheepshead minnow	Acute	LC50=520	highly toxic	40228401
Sheepshead minnow	Acute	LC50 (sulfone metabolite) = 1060	moderately toxic	44369901
Sheepshead minnow	Acute	LC50 (sulfone metabolite) = 11300	slightly toxic	44369902
Sheepshead minnow	Early Life Stage	NOAEC=16.2	N/A	42629001
Sheepshead minnow	Full Life Cycle	EC05=0.96***	N/A	43960501
Eastern Oyster	Acute	EC50=720	highly toxic	40228401
Brown shrimp	Acute	EC50=15	very highly toxic	40228401
Mysid	Life Cycle	EC05=2.35***	N/A	43610901

* The species listed and used in risk assessment were selected from the toxicity data because they seemed to represent a distribution of sensitivity.
** An early life stage study was not conducted with bluegill, but was derived from a rainbow trout study (MRID 41935801).

b. Environmental Exposure to Disulfoton

EPA uses models to estimate exposure of nontarget plants and animals to disulfoton. For terrestrial birds and mammals, the Agency first estimates initial levels of Disulfoton residues on various food items consumed by wildlife using the Fletcher nomogram(MRID # (45374901) followed by a first order decline model such as FATE5. This assessment was further characterized after reviewing one residue monitoring study conducted in potatoes.. Based on the results of this study a foliar dissipation half life of 3.3 was derived and was subsequently used to estimate terrestrial exposure using the FATE5 model.

The following table shows predicted residues immediately after application on terrestrial food items that result from a single application of disulfoton calculated from Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994):

Table 9: Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Application at 1 lb ai/A

Food Items	EEC (ppm) Predicted Maximum Residue	EEC (ppm) Predicted Mean Residue
Short grass	240	85
Tall grass	110	36
Forage and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

These residues served as the initial concentrations from which first-order residue declines were calculated. When considering repeat applications, degradation over time is simulated from the first application to a period following the last application. The time period modeled varies, depending on the number of applications, the interval between applications. However 30 days was usually modeled unless otherwise specified. The FATE5 program generates a peak value as well as a time-weighted average value for the time period modeled. The Fletcher peak maximum value for the food item was compared to the acute toxicity value to produce the acute Risk Quotient (RQ). For chronic risk, the Fletcher maximum value was used as the initial input. Both the peak maximum for short grass and time-weighted average maximum EECs for short grass and other food items were used to compute chronic RQs.

For aquatic organisms, EPA estimates the concentration of parent disulfoton in surface water using the Tier II PRZM/EXAMs models.

4. Nontarget Terrestrial Animal Risk

a. Risk to Birds and Mammals

EPA predicts acute risk to birds and mammals for both the granular (15 % ai) and liquid

EC (8 % ai) formulations. RQs for birds and mammals are summarized in Tables 10 thru 12 below. Bird kills have been associated with applications of granular disulfoton to a tree nursery and potatoes. Field studies in potatoes and small grains showed small mammals to be sensitive to the 15% granular product and jackrabbits to be sensitive to the liquid products. Also, EPA has received a poisoning report of Swainson hawks that died following ingestion of disulfoton contaminated grasshoppers. The Agency predicts chronic risk to birds and mammals from liquid disulfoton (8 EC); mammals appear to be at greater risk than birds.

Table 10. Summary of Acute Ecological Risks to Birds and Mammals potentially exposed to Di-Syston 8EC (liquid) in food.

Use Scenario				Risk Quotients (RQs)	
Crop	Application Rate/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications	Birds[1] LC50 =333 ppm	Mammals[2] Estimated 1 day LC50 = 2- 12.7 ppm
Tobacco	4 lbs ai/A aerial (soil), unincorporated	1	N/A	0.2-2.8 Adjacent to field	0.9-480 Adjacent to field
	4 lbs ai/A ground (soil), broadcast, incorporated	1	N/A	0.2-1.6 Within field granivore & insectivore	0.9-270 Within field, granivore insectivore
Potatoes NW only	3 lb ai/A ground (foliar), chemigation	1	N\A	0.1-2.2	0.7-360
Potatoes	3 lb ai/A ground (soil), unincorporated side dress	1	N/A	approx 0.1- 2.2 Slightly less than foliar	approx 0.7-360 Slightly less than foliar
	3 lb ai/A ground (soil), broadcast, incorporated	1	N/A	0.1-1.2 Within field granivore & insectivore	0.7-202 Within field, granivore insectivore
	3 lb ai/A ground (soil), in furrow or injection	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application
Peas & Lentils	2.5 lbs ai/A ground (soil) injection or in furrow	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application
Chili peppers	2 lbs ai/A ground (soil), broadcast, incorporated	1	N/A	0.1-0.8 Within field granivore & insectivore	0.5-135 Within field granivore & insectivore

Use Scenario				Risk Quotients (RQs)	
Crop	Application Rate/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications	Birds[1] LC50 =333 ppm	Mammals[2] Estimated 1 day LC50 = 2- 12.7 ppm
Beans (snap, dry & lima), lettuce, cabbage	2 lbs ai/A ground (soil), injection	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application
Cotton, sorghum Broccoli, Wheat, cauliflower, brussels sprouts, cabbage, barley	1 lbs ai/A ground (soil), injection	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application
Wheat	0.75 lb ai/A aerial (foliar)	1		0.03- 0.5	0.2-90
Poplars for pulp wood	3 lb ai/A ground (soil), unincorporated	3	21 day interval	0.1-2.2	0.7-364
Asparagus	1 lb ai/A ground and or aerial (foliar)	3	assumed 21 day interval	0.05-0.7	0.2-121
Barley	1 lb ai/A ground and or aerial foliar	2	21 day interval	0.05-0.7	0.2-121
Potato (East of Rockies only), brussels sprouts, cauliflower	0.5 lb ai/A aerial or ground (foliar)	3	14 days	0.02-0.4 Ground less risk than aerial	0.13-63 Ground less risk than aerial
Sorghum	0.5 lb ai/A aerial (foliar)	2	14 days	0.02-0.4	0.1-63
			3 days	0.03-0.5	0.2-92
Cotton (SLN)TX	0.2 lb ai/A aerial (foliar)	2	21 days	0.01-0.15	0.05-24

1 RQs for birds vary according to food items consumed; the range is presented here.

2 RQs for mammals vary according to body weight and food items consumed; the range is presented here. Additional information can be found in the September 5, 2000, revised environmental risk assessment.

Table 11. Summary of Chronic Ecological Risks to Birds and Mammals potentially exposed to Di-Syston 8EC (liquid) in food. Unless specified otherwise the RQ is based on a a 3.3 day half life and 30 day average maximum residue values. RQ in ( ) is based on peak maximum residues short grass.

Use Scenario				Risk Quotients (RQs)	
Crop	Application Rate/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications	Birds[1] NOAEC = 37 ppm	Mammals[2] NOAEC = 0.8 ppm
Tobacco	4 lbs ai/A aerial (soil), unincorporated	1	N/A	0.3-4.5 (26)	13-210 (1200)
	4 lbs ai/A ground (soil), broadcast, incorporated	1	N/A	0.3-2.5 (14) Within field granivore & insectivore	13-118 (675) Within field, granivore insectivore
Potatoes NW only	3 lb ai/A ground (foliar), chemigation	1	N\A	0.2-3.4 (19)	9.8-158 (900)
Potatoes	3 lb ai/A ground (soil), unincorporated side dress	1	N/A	approx 0.2-3.4 (19) Slightly less than foliar	approx 9.8-158 (900) Slightly less than foliar
	3 lb ai/A ground (soil), broadcast, incorporated	1	N/A	0.2-1.9 (11) Within field granivore & insectivore	9.8-89 (506) Within field, granivore insectivore
	3 lb ai/A ground (soil), in furrow or injection	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application
Peas & Lentils	2.5 lbs ai/A ground (soil) injection or in furrow	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application
Chili peppers	2 lbs ai/A ground (soil), broadcast, incorporated	1	N/A	0.1-1.3 (7.3) Within field granivore & insectivore	6.6-59 (337) Within field granivore & insectivore
Beans (snap, dry & lima), lettuce, cabbage	2 lbs ai/A ground (soil), injection	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application

Use Scenario				Risk Quotients (RQs)	
Crop	Application Rate/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications	Birds[1] NOAEC = 37 ppm	Mammals[2] NOAEC = 0.8 ppm
Cotton, sorghum Broccoli, Wheat, cauliflower, brussels sprouts, cabbage, barley	1 lb ai/A ground (soil), injection	1	N/A	risk can not be quantified, but less than surface application	risk can not be quantified, but less than surface application
Wheat	0.75 lb ai/A aerial (foliar)	1	N/A	0.05-0.85 (4.9)	2.5-40 (225)
Poplars for pulp wood	3 lb ai/A ground (soil), unincorporated	3	21 day interval	0.3-4.9 (20) *63 day ave*.	14-225 (911) *63 day ave*
Asparagus	1 lb ai/A ground and or aerial (foliar)	3	assumed 21 day interval	0.1-1.6 (6.6) Ground less risk than aerial *63 day ave*.	4.7-75 (304) Ground less risk than aerial *63 day ave*.
Barley	1 lb ai/A ground and or aerial (foliar)	2	21 day interval	0.1-1.6 (6.6) Ground less risk than aerial *42 day ave*	4.7-75 (304) Ground less risk than aerial *42 day ave*
Potato (East of Rockies only), brussels sprouts, cauliflower	0.5 lb ai/A ground or aerial (foliar)	3	14 days	0.08-1.2 (3) Ground less risk than aerial *42 day ave*	3.5-56 (158) Ground less risk than aerial *42 day ave*
Sorghum	0.5 lb ai/A aerial (foliar)	2	14 days	0.07-1.1 (3)	3.2-52 (158)
			3 days	0.2-3 (5) *9 day ave*	8.6-138 (230) *9 day ave*
Cotton (SLN)TX	0.2 lb ai/A aerial (foliar)	2	21 days	0.02-0.3 (1) *42 day ave*	0.9-15 (61) *42 day ave*

1 RQs for birds vary according to food items consumed; the range is presented here.
2 RQs for mammals vary according to body weight and food items consumed; the range is presented here. Additional information can be found in the September 5, 2000, revised environmental risk assessment.

The Agency's assessment suggests the potential for the 8 EC formulation (liquid) to cause acute effects to non endangered herbivorous birds from a single aerial application at or above 0.75 lb ai/A. Endangered granivores would be at risk from a single, 2.0 lb ai/A soil incorporated application. The avian acute RQs range from less than 0.1 for potatoes at 3.0 lbs ai/ai when applied in furrow or soil injected to 2.8 on short grass from a single, 4 lb ai/A aerial application

to tobacco. For the same use patterns/food items, mammalian acute RQs range from less than 0.1 to 480. A comparison of the NOAECs from avian reproduction studies to estimated exposure concentrations from uses other than in furrow or soil injection, produced chronic RQs ranging from 0.02 for cotton (the 42-day average on seeds for 2 aerial applications with 21 day intervals at 0.2 lbs ai/A) to 26 for tobacco (the peak on short grass for a single aerial applications at 4.0 lbs ai/A). For the same use patterns, when the NOAEL in the 2-generation rat study is used as an endpoint, the chronic RQs range from 0.9 to 1200. For both birds and mammals, most of the RQs are above the Agency's level of concern for chronic effects. These exceedences last for several weeks. In all cases (except for in furrow or soil injection) for mammal, but only in a few uses for birds, not only the peak residues, but also the time weighted average residues exceed the test levels at which chronic effects were observed (LOAECs).

Registrants have expressed concern regarding the Agency's use of Fletcher values and models such as FATE5 in its preliminary exposure assessment. Two field residue monitoring studies submitted by a registrant were pertinent to current uses of disulfoton on potatoes. In the study (MRID #412018-01), Di-Syston 8 was aerially applied to potato foliage 3 times (6 to 10 day intervals) at 1 lb ai/acre in Michigan. Residues on the potato leaves peaked at 105 ppm after the 2nd application and had a mean value of 41 ppm over the course of the study. These values are reasonably close to the FATE5 model (scenario was 1 lb ai/A, 3 applications, 10 day interval, 21 day sampling period, and half life 3.3 days) estimate of residues on broadleaves of 153 ppm (peak) and 51ppm (mean). A second residue monitoring study (MRID #411189-01) in Michigan was performed, in which Di-Syston 8 was soil incorporated by ground equipment, (initially in furrow at planting at 3 lb ai/ acre and 6 - 7 weeks later as a side dressing at 3 lbs ai/ acre). As was expected the residues on potato foliage were lower (peak was 44 ppm and mean was 8 ppm) than in the first study. Finding residues is due in part because disulfoton is systemic and secondly, though directed at the soil, some spray would contact the emerged plants during the second application. In conclusion, the foliar application study appears to support the use of the Fletcher values in a model such as FATE5 to predict residues on foliage.

The acute and chronic RQs are based solely on dietary exposure via contaminated food sources. Other routes of exposure, including dermal, inhalation, and drinking from contaminated puddles might also be important (Driver et al. 1991) and could further increase acute risks if methods were available to include them in the risk assessment. Other factors contributing to uncertainty (especially for chronic effects) include when exposure occurs during the reproductive cycle; the duration of exposure required to cause a physiological effect and sub lethal effects to adults that may impact breeding and nurturing behavior.

The following table summarizes the acute risk to birds and mammals from the use of the granular formulation (15 G) of disulfoton.

Table 12. Acute Risk Estimates for Birds and Mammals Exposed to Di-Syston 15G (Granular). Based on mallard ago LD50 (6.54mg/kg) and rat a.o. LD50 (1.9 mg/kg).

Use Scenario				RQs	
Crop	Application Rate lb ai/A and or (**oz.ai/ 1000 ft**)	Application Method	mg ai/ft^2 exposed on soil surface	Birds	Mammals
Christmas trees (approx 1700/A)	78 **(0.69 oz ai/ tree ~ 2 ft^2**)	Spot treatment/broadcast, unincorporated	approx 9,780	approx 1,500-75,200	approx 5,100-257,300
Christmas trees (SLN) NC approx 1700/A	4.5 (**0.04 oz ai / tree ~ 2 ft^2**)	Spot treatment/broadcast, unincorporated	567	approx 85-4,350	approx 300-14900
Tobacco	4 (**6**)	Banded (assume 6 inches), incorporated	51	7-392	26-1342
		Banded (assume 12 inches), incorporated	25.5	3.5-196	13-671
		Broadcast, incorporated	6.2	0.9-48	3-164
Ornamental flowers (gladiolus)	28.6 (**1.05 oz/100 ft^2**)	broadcast, incorporated	45	6.8-346	24-1184
Ornamental flowers (gladiolus)	4.5(**0.16 oz/100 ft^2**)	broadcast, incorporated	7	1-54	3.6-184
Ornamental flowers (gladiolus)	6 (**11.25**)	banded–in trench, incorporated	assumed zero	assumed zero	assumed zero
Potatoes	3 (**3.4**)	Banded (assume 6 inches) incorporated	28.9	4.5-225	15-772
		Broadcast, incorporated	4.7	0.7-35	2.5-123
		In furrow, incorporated	1.9	0.3-15	1-51
Peas and Lentils	2.5	Broadcast, unincorporated	26	3.8-198	13-683
Peppers	2 (**2**)	Banded (assume 6 inches), incorporated	17	2.5-130	9-447
Soy beans	1 (**1.2**)	Banded (4 inch), incorporated	17	2.5-130	9-447
Cabbage	1.5 (**1.7**)	Banded (assume 6 inches), incorporated	14.4	2.2-110	7.5-378
Sorghum[1]	1	Broadcast to whorls	10.4	1.5-80	5-270

Use Scenario				RQs	
Crop	Application Rate lb ai/A and or (**oz.ai/ 1000 ft**)	Application Method	mg ai/ft^2 exposed on soil surface	Birds	Mammals
Barley, wheat	1	Broadcast, unincorporated	10.4	1.5-80	5-270
		Drilled	approx 0.1	approx <0.1-0.8	approx <0.1-2.7
Clover [1](for seed) SLN	1	Broadcast to foliage, unincorporated	10.4	1.5-80	5-270
Cotton, sorghum	1 (**1.2**)	Banded (assume 6 inches), incorporated	10.2	1.5-80	5-270
Peanuts, cole crops,	1 **(1.1**)	Banded (assume 6 inches), incorporated	9.3	1.4 -70	5-240
Beans (Lima, Dry)	1 (**0.9**)	Banded (6inch), incorporated	7.6	1.1-70	4-200
Ornamental trees (Holly, birch)	4.5	Broadcast, incorporated	7.0	1-54	3.6-184
Ornamental trees (Holly, birch)	(**12 oz**)	In furrow	6.8	1-52	3.5-178
Cotton, sorghum	1 (**1.2**)	In furrow, incorporated	0.68	0.1-5	0.3-17
Peanuts	1 (**1.1**)	In furrow, incorporated	0.62	0.1-5	0.3-17

1Some granules will be retained in/on foliage and could be ingested by non target birds and mammals.
RQs for birds and mammals vary according to body weight; the range is presented here. Additional information can be found in the September 5, 2000, revised environmental risk assessment.

The Agency's assessment suggests potential for the 15 G formulation to cause acute risk to birds from a single application at or above the lowest application rate of 1.0 lb ai/A even when the material is incorporated. The avian acute RQs for small birds range from 5 for the in furrow, 1 lb ai/A rate on cotton to approximately 75,200 for 78 lb ai/A, unincorporated spot treatment to Christmas trees. For the same use patterns/food items, small mammal acute RQs range from 17 to 257,300. EPA can not estimate long term exposure from granular applications because the granules are not expected to remain in tact over extended periods. The chemical is expected to become distributed in the soil, as the granules dissipate. However even a brief exposure period may be sufficient to cause chronic risk because disulfoton is chronically toxic to birds and mammals at low dietary concentrations.

Risk to birds and mammals from the use of 15 G (SLN) on Christmas tree farms in North

Carolina

Christmas tree farms and the adjacent areas -- forests and or pasture – provide excellent habitat for a great variety of wild life. The North Carolina Christmas Tree community has submitted numerous testimonials emphasizing the ever increasing numbers and diversity of wild life . This includes game animals such as turkey rearing young amidst the trees, song birds, rodents and foxes. Although this information is intended to suggest there is little or no negative impact from not only disulfoton, but other pesticides or cultural practices as well, the Agency would prefer to receive documented surveys or research before making a final determination.

b. Non target Insects

Disulfoton is moderately toxic to honey bees and its sulfoxide and sulfone degradates are highly toxic to bees. Although a 24 hour residual study on the 8 EC indicated no toxicity to honey bees following exposure to alfalfa that had been treated 3 hours earlier at a rate of 1.0 lb/A., there is uncertainty as to the risk from later exposure and a longer period of time to the more toxic degradates. Furthermore, the risk from higher rates – especially aerial and foliar applications – can not be assessed without additional data.

5 Risk to Nontarget Aquatic Animals

Disulfoton technical is moderately to very highly toxic to freshwater fish; very highly toxic to freshwater invertebrates; highly toxic to estuarine fish and highly to very highly toxic to estuarine invertebrates. None of these organisms were at risk from disulfoton when the EC was soil injected. Neither fresh water nor estuarine fish acute risk Levels Of Concern (LOC) are exceeded; however, a few uses exceed restricted use and endangered species concerns for fresh water fish. Chronic risk to freshwater and estuarine fish may occur from uses where single application rates are equal to 4 lb a.i./A. Estuarine fish may also be at chronic risk from 2 or more applications of the EC formulation at rates equal to or greater than 1 lb ai/A. Although many modeled crop scenarios suggest a potential for acute risk for freshwater invertebrates; except for the greater risk from the tobacco use, RQs were between 0.5 and 2.1 with most being less than one. Typically, unless soil injection was employed, the invertebrate restricted use and endangered species concerns were exceeded. Chronic risk to fresh water invertebrates (i.e., number of young produced, their survival and growth) is predicted for all modeled scenarios. Although modeling predicts acute and chronic risks estuarine/ marine invertebrates for a few uses on such sites as tobacco, barley and cotton, there is uncertainty in the exposure estimates and the RQs are less then 2 for acute and less then 6 for chronic risk. RQs for fish and invertebrates are summarized in Tables 13 and 14.

(i) Freshwater Fish – Acute and Chronic Risk

Acute risk LOC is not exceeded for any use patterns. RQs range from <0.01 (soil injection of the EC to any crop or one unincorporated application of the 15 G by ground

equipment to soil at 1.0 lb ai/A to wheat) to 0.48 (1 aerial application of 4.0 lb ai/A to soil for tobacco). The restricted use LOC is exceeded by a single application at rates greater than or equal to1.0 lb ai/A.. The endangered species LOC is exceeded by: 1) a single, unincorporated application at rates greater than or equal to 0.75 lb ai/A and 2) 2 or more unincorporated applications at 0.2 lbs ai/A. Chronic risk is only exceeded by one application regime in tobacco - the RQ is 1.5 for a single aerial application to soil (followed by incorporation) at 4.0 lb ai/A.

While the acute LC50 was never exceeded by peak concentrations mortality is predicted for some application regimes of the EC for tobacco, barley and possibly asparagus (other than N. West). In a series of miniature ponds known as microcosms, bluegills were exposed to a range of concentrations for 27 days. This resulted in a 27 day LC10 of 4.7 parts per billion. Since LC10 is exceeded by the modeled 21-day average EEC's (4.5 to 12 ppb) for these 3 uses, this suggests use of disulfoton adjacent to aquatic sites may result in mortality to freshwater fish. Three fish kills associated with tobacco and wheat were reported to the Agency in which disulfoton and or two metabolites – the sulfoxide and sulfone were present. These metabolites are persistent and 1/3 to 1/5 less toxic than disulfoton; they may have contributed to the impact. However, it should be noted that other toxic chemicals were also discovered in the water in two of the incidents and in the other instance runoff contributed decaying vegetation and sediment that may have resulted in very low oxygen levels.

(ii) Freshwater Invertebrates

a Acute Risk

The fresh water invertebrate acute risk RQs range from <0.01 (soil injection of the EC to any crop or one unincorporated application of the 15 G by ground equipment to soil at 1.0 lb ai/A to wheat) to 4.8 (1 aerial application, followed by incorporation, of 4.0 lb ai/A to soil for tobacco). Acute risk is usually exceeded by: 1) one incorporated or unincorporated application of the EC at rates equal to or greater than 1.0 lb ai/A; 2) one unincorporated application of the 15 G at rates equal to or greater than 1.0 lb ai/A; 3) 2 or more aerial unincorporated applications of the EC at rates equal to or greater than 0.2 lbs ai/A. 4) 2 or more unincorporated ground applications of the EC at rates equal to or greater than 0.5 lbs ai/A. The restricted use LOC is exceeded by nearly all techniques for all modeled sites. The exceptions are soil injection applications of the EC; one unincorporated application of the 15 G by ground equipment to soil at 1.0 lb ai/A to wheat and one soil incorporated, ground application of the 15 G at 2.0 lbs ai/A for chili peppers. All techniques for all modeled sites exceed the endangered species LOC except for soil injection of the EC and one unincorporated application of the 15 G by ground equipment to soil at 1.0 lb ai/A to wheat.

b Chronic Risk

Chronic risk is anticipated from all regimes for all modeled sites except for soil injection and one unincorporated application of the 15 G by ground equipment to soil at 1.0 lb ai/A to

wheat. RQs for all of the modeled crop scenarios greatly exceeded the LOC of one. The 21-day average EECs for the modeled sites that exceeded chronic risk concerns ranged from 0.2 ppb (chili peppers– single application of soil incorporated 15 G at 2 lbs ai/A) to 12 ppb (tobacco– a single aerial application, followed by soil incorporation of the EC at 4 lbs ai/A). Invertebrate life-cycle testing on daphnia with disulfoton showed impacts to reproductive parameters (number of young produced by adults) as well as impacts to survival and growth occurring between 0.037 and 0.07 ppb. With the exception of soil injection of the EC formulation (where residues in water were considered to be zero) the RQs ranged from 5 to 324. Because invertebrates have a short life cycle, their reproduction is more likely to be at least temporarily impacted by a brief exposure of adults to disulfoton concentrations near the NOAEC.

A microcosm study toxic suggests that disulfoton's impacts to the invertebrate community may be short term and only slightly extended due to the toxicity and persistence of the degradates of disulfoton. Similarly to their toxicity to freshwater fish the two primary degradates – D. sulfone and D. sulfoxide – are respectively approximately 1/3 to 1/5 as acutely toxic as parent disulfoton.. The chronic toxicity to daphnia magna of these two degradates is approximately 1/3 (for D. sulfone) and 1/45 (for D. sulfoxide). The invertebrates were dosed four times during the first 28 days of the 77 day study. An analysis of the data suggests short term negative impact from exposure as low as 3 ppb, but recovery occurred by the end of the study for most invertebrate populations exposed to 30 ppb. It should be noted that at this time the Agency has not validated the significance of microcosm studies.

(iii) Estuarine and Marine Fish – Acute and Chronic Risk

There is uncertainty in using the PRZM/EXAMS EECs derived for ponds to predict exposure to marine/estuarine organisms. The scenarios modeled are based on hydrologic data for ponds. Estuarine fish residing in the upper reaches of tributaries of bays would be exposed to residues coming from adjacent crop lands. Exposure to pesticide residues in estuarine habitats may be higher or lower than that predicted for pond, depending upon the volume of water and residence time in the estuary. An additional uncertainty is the fact that the only species tested -- Sheepshead minnow-- probably does not represent the true range of sensitivity of marine or estuarine fish; therefore both the acute and chronic risk may be underestimated. Nevertheless, acute risk to estuarine and marine fish appears to be low, because the RQs for all modeled crops are less than 0.05 –the LOC for endangered species.

Concerning chronic risk, in addition to the previously stated uncertainties, other uncertainties are the duration adult fish must be exposed to disulfoton for their reproductive systems to be effected and when in their reproductive cycle is the impact occurring. For example, even if adults are effected after an exposure of only a week, disulfoton residues may dissipate from an area within several days resulting in little or no chronic risk. However, based on modeling and the results (endpoints of concern included fecundity, hatching success, and growth) of the fish full life-cycle test only some of the uses on 3 crops – tobacco, cotton and barley – slightly exceed the chronic risk levels of concern. The RQs showing exceedences range

from 2 for barley (2 lb ai/A, 2 applications at 21 day intervals) to 5 for tobacco (a single application of the liquid formulation at 4 lb ai/A). All other modeled uses had RQs less than the level of concern of 1.

(iv) Estuarine and Marine Invertebrates – Acute and Chronic Risk

Similar to the risk assessment for estuarine fish the same uncertainties associated with exposure apply to estuarine invertebrates. Most of the modeled scenarios do not exceed the acute or restricted use criteria for marine and estuarine invertebrates. The RQs range from <0.01 (a single soil injected application of 1- 2.5 lbs ai/A for a variety of vegetables) to 1.26 (one aerial application of the liquid formulation at 4 lbs ai/A to tobacco). Although nearly all uses exceeded endangered species risk concerns, currently there are no marine or estuarine invertebrates listed as endangered. Few of the modeled crop scenarios show the potential for chronic risk to marine and estuarine invertebrates; those that do (ie some uses in tobacco, cotton and barley) have RQs between 1 and 5. Mysid shrimp are less sensitive than daphnia, the surrogate for freshwater invertebrates; therefore, on the basis of this limited data, the chronic impact to estuarine invertebrates appears to be lower than freshwater invertebrates.

The following 3 tables – 13 thru 15 – contain the Estimated Environmental Concentrations (EECs) and Risk Quotients (RQs) for the risk assessment for freshwater and estuarine organisms.

Table 13. Tier II Upper Tenth Percentile EECs for Disulfoton Parent Used on barley, cotton, potatoes, tobacco, and wheat for current and proposed applications estimated using PRZM3/EXAMS

Crop	Disulfoton Application Rate/Number of Apps/Interval/Incorp. Depth/method[1]	Concentration (µg/L) (1-in-10 annual yearly maximum value)						Mean of Annual Means (µg/L)
	lb.ai/A/ #/ days/ inches	Peak	96-Hour Avg.	21-Day Avg.	60-Day Avg.	90-Day Avg.	Annual Avg.	
Tobacco	4.0/1/0/2.5/a,s	18.97	17.26	11.86	7.12	4.91	1.24	0.83
Tobacco	4.0/1/0/2.5/g,s	12.02	10.93	8.08	4.39	3.04	0.76	0.35
Tobacco	4.0/1/0/2.5/g,s (granular)	2.09	1.90	1.41	0.75	0.52	0.13	0.05
Barley	1.0 /2/21/0/a,f	8.28	7.44	5.52	3.58	2.91	0.75	0.49
Barley	1.0 /2/21/0/g,f	6.61	5.94	4.47	2.65	2.04	0.52	0.25
Barley	1.0/2/21/0/g,s (granular)	6.41	5.75	4.35	2.56	1.90	0.47	0.19
Cotton	1.0 /1/0/2.5/g,s	4.28	3.89	2.83	1.46	1.00	0.25	0.10
Cotton SLN (TX)	0.2/2/21/0/a,f	2.71	2.36	1.55	0.92	0.66	0.18	0.13
Cotton	1.0/1/0/2.50/g,s (granular)	0.79	0.72	0.52	0.27	0.19	0.05	0.02
Cotton, wheat	1/1/0/2.5/g,s (injection)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potatoes	0.5 /3/14/0/a,f	2.91	2.59	2.07	1.33	0.94	0.23	0.20
Potatoes	3.0/1/0/0/g,s	2.53	2.26	1.74	0.92	0.63	0.17	0.11
Potatoes	3.0/1/0/2.5/g,s	1.81	1.63	1.27	0.64	0.44	0.11	0.09
Potatoes	0.5 /3/14/0/g,f	1.32	1.18	0.87	0.50	0.36	0.09	0.06
Potatoes	3.0/1/0/2.5/g,s (granular)	0.53	0.47	0.35	0.18	0.12	0.03	0.11
Sorghum	0.5/2/14/0a,f	2.98	2.59	1.74	1.04	0.71	0.20	0.13

Crop	Disulfoton Application	Concentration (µg/L) (1-in-10 annual yearly maximum value)						Mean of Annual Means (µg/L)
	Rate/Number of Apps/Interval/Incorp. Depth/method[1]							
	lb.ai/A/ #/ days/ inches	Peak	96-Hour Avg.	21-Day Avg.	60-Day Avg.	90-Day Avg.	Annual Avg.	
Sorghum	0.5/2/3/0a,f	2.90	2.52	1.76	0.94	0.64	0.18	0.13
Sorghum	0.5/2/14/0g,f	2.00	1.74	1.03	0.55	0.38	0.11	0.04
Sorghum	1/1/0/4 g,s (granular)	0.86	0.78	0.51	0.23	0.16	0.05	0.02
Winter wheat	0.75/1//0/0 a,f	2.19	1.98	1.54	0.77	0.53	0.14	0.11
Winter wheat	0.75/1//0/0 g,f	0.95	0.85	0.60	0.30	0.21	0.05	0.03
Winter wheat	1/1/0/0 g,s (granular)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spring Wheat	0.75/1//0/0 a,f	2.10	1.96	1.54	0.86	0.59	0.16	0.13

Values are Tier II Estimated Environmental Concentrations (EECs) for Disulfoton Parent using PRZM/EXAMS based on Current and Proposed Rates for Disulfoton

All EECs are the 1-in-10 annual yearly maximum values.

[1] Method of application: g = ground, a = aerial f = foliar and s = soil; unless specified the emulsifiable concentrate (EC) was modeled.

Table 14. Acute Risks to Freshwater and Estuarine Organisms Potentially Exposed to Disulfoton in Surface Water

Use Scenario					Risk Quotients (RQs = EEC/Tox value) for Aquatic Organisms			
Crop and Formulation (liquid unless specified)	Application Rate (lbs ai/A)/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications (days)	Peak (ppb ai)	Freshwater		Estuarine	
					Fish (Bluegill) LC50 39 ppb	Invertebrates (glass shrimp) LC50 3.9 ppb	Fish (Sheepshead Minnow) LC50 520 ppb	Invertebrates (Brown Shrimp) LC50 15 ppb
Tobacco	4, aerial (soil) incorporated	1	N/A	19	0.48	4.8	0.04	1.26
	4, ground (soil) incorporated	1	N/A	12	0.30	3	0.02	0.80
Tobacco (Granular)	4, ground (soil) incorporated	1	N/A	2	0.05	0.5	<0.01	0.13
Barley Asparagus[1]	1, aerial (foliar)	2	21	8.3	0.21	2.1	0.02	0.55
	1, ground (foliar)	2	21	6.6	0.17	1.7	0.01	0.44
Barley (Granular)	1, ground (soil) unincorporated	2	21	6.4	0.16	1.6	0.01	0.43
Cotton	1, ground (soil) incorporated	1	N/A	4.3	0.11	1.1	<0.01	0.28
Cotton (SLN) TX	0.2, aerial (foliar)	2	21	2.7	0.07	0.7	<0.01	0.18
Cotton (granular)	1, ground (soil) incorporation	1	N/A	0.8[2]	0.02	0.2	<0.01	0.05
Sorghum	0.5, aerial (foliar)	2	3	approx 3	0.08	0.77	<0.01	0.20
			14					
Sorghum	0.5, ground (foliar)	2	14	2	0.05	0.5	<0.01	0.13

Use Scenario					Risk Quotients (RQs = EEC/Tox value) for Aquatic Organisms			
Crop and Formulation (liquid unless specified)	Application Rate (lbs ai/A)/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications (days)	Peak (ppb ai)	Freshwater		Estuarine	
					Fish (Bluegill) LC50 39 ppb	Invertebrates (glass shrimp) LC50 3.9 ppb	Fish (Sheepshead Minnow) LC50 520 ppb	Invertebrates (Brown Shrimp) LC50 15 ppb
Sorghum	1, ground (soil) incorporated	1	N/A	between 0.9 and 2	0.04[3]	0.4[3]	<0.01[3]	0.10[3]
Sorghum (granular)	1, ground (soil) incorporated	1	N/A	0.9	0.02	0.2	<0.01	0.06
Cotton, peanuts, sorghum (granular)	1, ground (soil) in furrow	1	N/A	<0.8[3]	<0.02	<0.2	<0.01	<0.05
Cotton	1, ground (soil) injection	1	1	approx zero	<0.01	<0.01	<0.01	<0.01
Potatoes	0.5, aerial (foliar)	3	14	2.9	0.07	0.7	<0.01	0.19
	3, ground (soil) unincorporated	1	N/A	2.5	0.06	0.6	<0.01	0.17
	3, ground (soil) in furrow	1	N/A	1.8	0.05	0.5	<0.01	0.12
	0.5, ground (foliar)	3	14	1.3	0.33	0.3	<0.01	0.09
Potatoes (N.West only)[4]	3, ground (foliar) chemigation	1	N/A	between 1.8 and 2.5	0.05[5]	0.5[5]	<0.01[5] N/A	0.14[5] N/A
Potatoes (granular)	3, ground (soil) incorporated	1	N/A	0.5	0.01	0.1	<0.01	0.03
Peas, lentiles[6]	2.5, ground (soil) in furrow	1	N/A	2.5	0.06	0.6	<0.01	0.17
Wheat (Fall)	0.75, aerial (foliar)	1	N/A	2.1	0.05	0.5	<0.01	0.14

Use Scenario					Risk Quotients (RQs = EEC/Tox value) for Aquatic Organisms			
Crop and Formulation (liquid unless specified)	Application Rate (lbs ai/A)/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications (days)	Peak (ppb ai)	Freshwater		Estuarine	
					Fish (Bluegill) LC50 39 ppb	Invertebrates (glass shrimp) LC50 3.9 ppb	Fish (Sheepshead Minnow) LC50 520 ppb	Invertebrates (Brown Shrimp) LC50 15 ppb
Wheat (Spring)	0.75, aerial (foliar)	1	N/A	2.2	0.06	0.6	<0.01	0.15
	0.75, ground (foliar)	1	N/A	0.9	0.02	0.2	<0.01	0.06
Wheat (granular)	1, ground (soil) unincorporated	1	N/A	<0.01	<0.01	<0.01	<0.01	<0.01
Chili peppers[7]	2, ground (soil) incorporated.	1	N/A	1.2	0.03	0.3	<0.01	0.08
Chili peppers[8] (granular)	2, ground (soil) incorporated.	1	N/A	0.3	<0.01	0.07	<0.01	0.02
Peas, lentils Beans (snap, dry & lima), lettuce, broccoli, cauliflower, brussels sprouts, cabbage, wheat, barley[9]	1 to 2.5, ground (soil) injection	1	N/A	approx zero	<0.01	<0.01	<0.01	<0.01

1 The RQs for asparagus in the N West are assumed to be much less than for foliar applications to barley even though there is potential for three applications.. There is little or no rainfall causing runoff during the application period. (Personnel communication with Alan Schriber Wash State Dept of Ag). However, EECs may be higher where rainfall is expected.

2 In furrow locates most of the applied material lower in the soil profile than incorporation by tillage; therefore exposure from run off will be less.

3 RQ derived from the average of the range of EECs (1.45) divided by the toxicity value.

4 Other potato scenarios were for Maine where run off and rainfall is greater than N West. Although drift may be greater than conventional ground spray (1 %) the proximity to adjacent water bodies is farther in the N West. Finally, the amount available for runoff is less when material is applied to foliage rather than soil.

5 RQ derived from the average of the range of EECs (2.15) divided by the toxicity value.

6 EEC is estimated to be proportional to the EEC for potato (3 lb ai/A ground application of liquid when in furrow)

7 EEC estimated to be proportional to the EEC for potato (3 lb ai/A ground application of liquid, soil incorporation)
8 EEC estimated to be proportional to the EEC for potato (3 lb ai/A ground application granular, soil incorporation)
9 EEC is estimated to be the same as for cotton (1 lb ai/A ground application of liquid when injected = approx. zero)

Based on the data described above, disulfoton poses the greatest acute risk to freshwater invertebrates and the least risk to estuarine fish.

Table 15. Chronic Risks to Freshwater and Estuarine Organisms Potentially Exposed to Disulfoton in Surface Water

Use Scenario							Risk Quotients (RQs =EEC/NOAEC)[1] for Aquatic Organisms			
Crop and Formulation (liquid unless specified)	Application Rate (lbs ai/A)/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications (days)	Day Ave (ppb ai)			Freshwater		Estuarine	
				21	60	90	Fish (Bluegill)[2] 4.6 ppb	Invertebrates (Daphnia) 0.037 ppb	Fish (Sheepshead Minnow)[3] 0.96 - 16.2 ppb	Invertebrates (Mysid Shrimp) 2.35 ppb
Tobacco	4, aerial (soil) incorporated	1	N/A	12	7	5	1.5	324	0.4 - 5	5
	4, ground (soil) incorporated	1	N/A	8	4	3	0.9	216	0.2 - 3	3
Tobacco (Granular)	4, ground (soil) incorporated	1	N/A	1.4	0.7	0.5	0.1	38	<0.1 - 0.5	0.6
Barley, asparagus[4]	1, aerial (foliar)	2	21	5.5	3.6	2.9	0.8	149	0.2 - 3	2.3
	1, ground (foliar)	2	21	4.5	2.6	2	0.6	122	0.2 - 2	1.9
Barley (Granular)	1, ground (soil) unincorporated	2	21	4.3	2.5	1.9	0.5	116	0.1 -2	1.8

Use Scenario							Risk Quotients (RQs =EEC/NOAEC)[1] for Aquatic Organisms			
Crop and Formulation (liquid unless specified)	Application Rate (lbs ai/A)/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications (days)	Day Ave (ppb ai)			Freshwater		Estuarine	
				21	60	90	Fish (Bluegill)[2] 4.6 ppb	Invertebrates (Daphnia) 0.037 ppb	Fish (Sheepshead Minnow)[3] 0.96 - 16.2 ppb	Invertebrates (Mysid Shrimp) 2.35 ppb
Cotton	1, ground (soil) incorporated	1	N/A	2.8	1.5	1	0.3	76	<0.1 - 1	1.2
Cotton (SLN) TX	0.2, aerial (foliar)	2	21	1.5	0.9	0.7	0.2	40	<0.1 - 0.7	0.6
Cotton (granular)	1, ground (soil) incorporation	1	N/A	0.5[5]	0.3[5]	0.2[5]	<0.1	13	<0.1 - 0.2	0.2
Sorghum	0.5, aerial (foliar)	2	3	approx 1.7	approx 1.0	approx 0.7	0.2	46	<0.1 - 0.7	0.7
			14							
Sorghum	0.5, ground (foliar)	2	14	1.0	0.5	0.4	0.1	27	<0.1 - 0.4	0.4
Sorghum	1, ground (soil) incorporated	1	N/A	between 0.5 and 1.0	between 0.2 and 0.5	between 0.1 and 0.4	<0.1[6]	19[6]	<0.1 - 0.2[6]	0.3[6]
Sorghum (granular)	1, ground (soil) incorporated	1	N/A	0.5	0.2	0.1	<0.1	13	<0.1 - 0.1	0.2
Cotton, peanuts, sorghum (granular)	1, ground (soil) in furrow	1	N/A	<0.5[6]	<0.3[6]	<0.2[6]	<0.1	<13	<0.1 -< 0.2	<0.2
Cotton	1, ground (soil) injection	1	N/A	approx zero	approx zero	approx zero	<0.01	<0.01	<0.01	<0.01
Potatoes	0.5, aerial (foliar)	3	14	2	1.3	0.9	0.3	54	<0.1 - 0.9	0.8
	3, ground (soil) unincorporated	1	N/A	1.7	0.9	0.6	0.2	50	<0.1 - 0.6	0.7

Use Scenario							Risk Quotients (RQs =EEC/NOAEC)[1] for Aquatic Organisms			
Crop and Formulation (liquid unless specified)	Application Rate (lbs ai/A)/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications (days)	Day Ave (ppb ai)			Freshwater		Estuarine	
				21	60	90	Fish (Bluegill)[2] 4.6 ppb	Invertebrates (Daphnia) 0.037 ppb	Fish (Sheepshead Minnow)[3] 0.96 - 16.2 ppb	Invertebrates (Mysid Shrimp) 2.35 ppb
	3, ground (soil) in furrow	1	N/A	1.3	0.6	0.4	0.1	35	<0.1 - 0.4	0.5
	0.5, ground (foliar)	3	14	0.9	0.5	0.4	0.1	24	<0.1 - 0.4	0.4
Potatoes (N.West only)[7]	3, ground (foliar) chemigation	1	N/A	between 1.3 and 1.7	between 0.6 and 0.9	between 0.4 and 0.6	0.1[8]	40[8]	<0.1 - 0.5[8] N/A	0.6[8] N/A
Potatoes (granular)	3, ground (soil) incorporated	1	N/A	0.3	0.2	0.1	<0.1	8	<0.1 - 0.1	0.1
Peas, lentiles[9]	2.5, ground (soil) in furrow	1	N/A	1.1	0.5	0.3	0.1	30	<0.1 - 0.3	0.5
Wheat (Fall)	0.75, aerial (foliar)	1	N/A	1.5	0.9	0.6	0.2	40	<0.1 - 0.6	0.6
Wheat (Spring)	0.75, aerial (foliar)	1	N/A	1.5	0.8	0.5	0.2	40	<0.1 - 0.5	0.6
	0.75, ground (foliar)	1	N/A	0.6	0.3	0.2	<0.1	16	<0.1 - 0.2	0.3
Wheat (granular)	1, ground (soil) unincorporated	1	N/A	0.002	0.001	0.001	<0.01	<0.1	<0.01	<0.01
Chili peppers[10]	2, ground (soil), incorp.	1	N/A	0.8	0.4	0.3	<.1	21	<0.1 - 0.3	0.3
Chili peppers[11] granular	2, ground (soil), incorp.	1	N/A	0.2	0.1	0.07	<0.1	5	<0.1	<0.1

Use Scenario							Risk Quotients (RQs =EEC/NOAEC)[1] for Aquatic Organisms			
Crop and Formulation (liquid unless specified)	Application Rate (lbs ai/A)/ Method/ Site (foliar or soil)	Number of Applications per Season	Time Interval between Applications (days)	Day Ave (ppb ai)			Freshwater		Estuarine	
				21	60	90	Fish (Bluegill)[2] 4.6 ppb	Invertebrates (Daphnia) 0.037 ppb	Fish (Sheepshead Minnow)[3] 0.96 - 16.2 ppb	Invertebrates (Mysid Shrimp) 2.35 ppb
Peas, lentils beans (snap, dry & lima), lettuce, broccoli, cauliflower, brussels sprouts, cabbage, wheat, [12]	1 to 2.5, ground (soil), injection	1	N/A	approx zero	approx zero	approx zero	<0.01	<0.01	<0.01	<0.01

1Risk quotients for fresh water / estuarine invertebrates and freshwater fish are based on 21 and 60 day EECs, respectively.
2 Bluegill NOAEC (4.6 ppb) is derived from the less sensitive rainbow trout chronic:acute ratio of 0.119.
3 Risk quotients for estuarine fish are based on 60 and 90 day EECs. Lower value derived is from 60 EEC and fish early life stage (fertilized egg through swim-up stage of larvae). Higher value is from 90 day EEC and full life cycle (fertilized egg through survival of juveniles of next generation).
4 The RQs for asparagus in the N West are assumed to be less than for foliar applications to barley even though there is potential for three applications. There is little or no rainfall causing runoff during the application period. (Personnel communication with Alan Schriber Wash State Dept of Ag). However, EECs may be higher where rainfall is expected.
5 In furrow locates most of the applied material lower in the soil profile than incorporation by tillage; therefore exposure from run off will be less.
6 RQ derived from the average of the range of EECs divided by the toxicity value. The averages are as follows: 21 day ave.=0.7, 60 day ave.=0.3, 90 day ave=0.2.
7 Other potato scenarios were for Maine where run off and rainfall is greater than N West. Although drift may be greater than conventional ground spray (1 %) the proximity to adjacent water bodies is farther in the N West. Finally, the amount available for runoff is less when material is applied to foliage rather than soil.
8 RQ derived from the average of the range of EECs divided by the toxicity value. The averages are as follows: 21 day ave.=1.5, 60 day ave.=0.7, 90 day ave=0.5.
9 EEC is estimated to be proportional to the EEC for potato (3 lb ai/A ground application of liquid when in furrow)
10 EEC estimated to be proportional to the EEC for potato (3 lb ai/A ground application of liquid, soil incorporation)
11 EEC estimated to be proportional to the EEC for potato (3 lb ai/A ground application granular, soil incorporation)
12 EEC is estimated to be the same as for cotton (1 lb ai/A ground application of liquid when injected = approx. zero)

Based on the data described above, freshwater invertebrates are at greater chronic risk than fish or estuarine invertebrates.

Risks to Nontarget Organisms from the use of Disulfoton 15 on Christmas Trees in North Carolina

The use of Disulfoton 15 G in Christmas tree farms at this time can not be modeled for potential surface water contamination. EFED assumes the estimated concentration for the North Carolina 24 (c) use pattern -- 4.5 lbs ai/ A unincorporated -- may be similar to the values for the single 4.0 lb ai/A incorporated application of granular disulfoton to tobacco. Based on this assumption there is potential for acute risk and chronic to aquatic invertebrates and chronic risk to freshwater fish. This assumption would be more likely when the receiving body of water is a pond, rather than a stream. The Christmas tree use pattern has a higher rate than tobacco; the granules are unincorporated; and current cultural practices recommend maintaining vegetation under the trees and between the rows. Therefore while the first two conditions may increase the estimated concentrations above those for tobacco, the third condition may reduce the concentrations as the absence of soil erosion reduces the amount of disulfoton moving off site. Since this preliminary screen of the 24(c) exceeds levels of concern, the Sec 3 use at 59.7 lbs ai/A would exceed (perhaps by 20 fold) the same levels of concern for aquatic life as well as the acute risk for fish.

The North Carolina Christmas tree industry has provided information that has contributed to a refinement of EFED's risk assessment for aquatic organisms from Christmas tree farming. First, the nearly exclusive use for Disulfoton 15 G on Christmas trees throughout the United States is on Fraser fir grown in 6 counties in Western North Carolina, thereby localizing the exposure and precluding any estuarine exposure. Second, the primary aquatic sites adjacent to tree farms are streams, not ponds. Residues in these streams will be lower and of shorter duration than would be expected for a pond. Third, two rapid assessment macro invertebrate surveys of streams in the Western region of North Carolina have been submitted. These studies show that when conservation measures associated with Christmas tree farming in the Western counties of North Carolina are implemented, there may be only slight, short term impact to aquatic macro invertebrates from disulfoton use. The Agency concurs with the investigators that when implementing (but not limited to) conservation measures such as establishing ground cover throughout the farm, constructing and maintaining the fewest number of roads and bridges, creating a riparian zone to include vegetation and trees and employing Integrated Pest Management practices, there appears to be " ...little negative effect on the fauna of adjacent streams...." The slight negative effect that was observed seemed to impact stoneflies (Plecoptera) more than the two other orders– caddisflies (Trichoptera) and mayflies (Ephemeroptera) - that were the focus of the survey. In conclusion, aquatic macro invertebrates appear to have the capacity to recover from impacts that could be caused by disulfoton use on Christmas trees in Western North Carolina.

(e) Nontarget Plants

EPA was unable to conduct a risk assessment for nontarget plants due to a lack of test data. Nontarget plant testing was not required for disulfoton because it is not a herbicide. r, the Di- Syston 8 EC label contains phytotoxicity statements suggesting a potential risk to nontarget plants. Therefore Tier 1 seedling emergence (850.4100) and Tier I vegetative vigor (850.4150) are requested to support the liquid formulations of disulfoton.

(f) Endangered Species

For disulfoton, EPA has risk concerns for the following scenarios: avian acute, avian chronic, mammalian acute, mammalian chronic, freshwater fish acute, freshwater invertebrate acute, freshwater invertebrate chronic, marine/estuarine fish acute, marine/estuarine fish chronic, marine/estuarine invertebrate acute, and marine/estuarine invertebrate chronic. Endangered terrestrial, semi-aquatic and aquatic plants also may be affected, based on label statements indicating phytotoxicity.

The Agency has developed the Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement mitigation measures that address these impacts. The Endangered Species Act requires federal agencies to ensure that their actions are not likely to jeopardize listed species or adversely modify designated critical habitat. To analyze the potential of registered pesticide uses to affect any particular species, EPA puts basic toxicity and exposure data developed for REDs into context for individual listed species and their locations by evaluating important ecological parameters, pesticide use information, the geographic relationship between specific pesticides uses and species locations, and biological requirements and behavioral aspects of the particular species. This analysis will include consideration of the regulatory changes recommended in this RED. A determination that there is a likelihood of potential impact to a listed species may result in limitations on use of the pesticide, other measures to mitigate any potential impact, or consultations with the Fish and Wildlife Service and/or the National Marine Fisheries Service as necessary.

At present, the program is being implemented on an interim basis as described in a Federal Register notice (54 FR 27984-28008, July 3, 1989). A final program, which may be altered from the interim program, will be proposed in a Federal Register notice scheduled for publication in autumn of 2001.

(g) Ecological Incident Reports

Several reports of wildlife poisonings are associated with disulfoton. These poisoning incidents are summarized in Table 16 below. Some of these incident reports support EPA's concerns for acute risk.

Table 16. Chronological List of Ecological Incidents

Start Date	Misuse? (yes/no/unknown)	Incident Description
6/12/95	unknown	Johnston County, NC: Fish kill occurred in commercial fish pond. Crop fields nearby treated with pesticides. Water, soil and vegetation samples analyzed for a variety of pesticides. Disulfoton, as well as several other pesticides, was found at 0.2-2.5 ppm in vegetation samples. Possible certainty index for disulfoton. (Incident Report No. I003826-002).
1/24/94	unknown	Puerto Rico: 6 grackles fell dead from tree in yard of private residence. Dead heron and owl also found in vicinity. Use site and method not reported. Birds had depressed acetyl cholinesterase. Analysis of GI contents of a grackles showed disulfoton at 2.37 ppm wet weight. Highly probable certainty index for disulfoton. (Incident Report No. I003966-004).
6/11/94	unknown	Arapahoe CO: Fish kill following application of Di-Syston EC. to wheat just before heavy rain. Water samples contained disulfoton sulfoxide at 29.5-48.7 ppb and disulfoton sulfone at 0.0199-0.214 ppb. (Incident Report No. I001167-001).
6/18/93	No	Young County,TX: 18 Swainson's hawks dead, 1severely disabled in a cotton field. Cotton seed had been treated with disulfoton prior to planting, ~10 days before the birds were discovered. No additional applications of OP or carbamate pesticides made in vicinity of field. Autopsies showed no trauma or disease. Lab analysis showed insect material in GI tracts; this material contained disulfoton (~7 ppm); no other OP or carbamate insecticides were present. Hawks fed on insects, which had been feeding on the young cotton plants, which contained disulfoton residues. (L.Lyon, Div. of Environmental Contaminants, U.S. Fish and Wildlife Service, Arlington, VA.)
6/22/91	unknown	Onslow County, NC: Fish kill in pond at private residence. Pond received runoff from neighboring tobacco field; pondwater analysis showed disulfoton and several other pesticides, including endosulfan. Disulfoton sulfoxide found in water at 0.32 ppb. Endosulfan had highest concentration (1.2 µg/L), and is toxic to fish, but disulfoton cannot be ruled out as a possible cause of death. No tissue analysis. Possible certainty index for disulfoton. (Incident Report No. B0000216-025).
4/26/91	unknown	Sussex County, DE: 9 American robins dead following application of granular disulfoton at tree nursery. Corn and soybeans also in vicinity. No laboratory analysis. Probable certainty index for disulfoton. (Incident Report No. I000116-003).